Appendix C
Semiautomatic Central Control System

C-1. Central Control System

The essential feature of a automated system to achieve the objectives for safer, more efficient lock operation should include a centralized control house, located central to the lock operations and providing high visibility for operating equipment and navigation approaches. The central control system should consist of a computer system interfaced with programmable logic controllers (PLC's). The following paragraphs describe the salient features of the operational design for automation of Melvin T. Price Locks and Dam using PLC's. Design assumptions, criteria, and characteristics of each of the following systems are presented as an example of a functioning system installed in 1992.

a. Programmable logic controllers (PLC's). The PLC system for the lock will serve several functions. First, the PLC is the heart of the lock equipment controls. The logic, timing, counting, latching, and interlocking required to control the lock gates, valves, and auxiliary equipment will be contained within the PLC. Secondly, the PLC will serve as a multiplexer. Inputs and outputs will be wired to the PLC very efficiently. Significant wiring and conduit costs will be avoided by taking advantage of the PLC multiplexing ability. Finally, the PLC will be an interface device between the lock operators' industrial personal computers (IPC's) and the outside world. The PLC will monitor data from geographically diverse points and send it to the IPC's for display. The PLC will also accept commands from the computers and activate external equipment in response.

(1) PLC architecture. The PLC will consist of a central processor and four remote input/output (I/O) racks. Each I/O rack is geographically located to minimize the wiring to the devices that it monitors and controls. The I/O racks will communicate with the processor by means of fiber optic links, offering very high speed and electrical noise immunity.

(2) PLC interface. The PLC processor will communicate with the IPC's via a fiber optic network interface. The PLC will communicate the status of all monitored devices to the IPC's via this interface. The PLC will also receive commands from the IPC's on the interface. The logic within the PLC may be actuated by commands from the IPC'S or by inputs to the PLC from pushbuttons located in the local control houses.

(3) PLC system reliability. System reliability will be assured by using industry tested PLC's in a simple configuration. Backup processors and automatic switching of equipment at the PLC level, while commercially available, are not recommended for this application. Outages are infrequent and repairs can be quickly executed. Additionally, the emergency controls will allow lock operation even during PLC failure. Redundant processors add significant expense and additional equipment and wiring to fail. The power to the PLC will be backed by the lock emergency generator. Battery-powered memory modules in the processor and I/O racks will protect PLC memory until power is restored.

b. Industrial personal computers system (IPC's). The computer system for control and monitoring of the lock and dam will be located in a control console in the central control house (Figure C-1). The computer system will serve several functions:

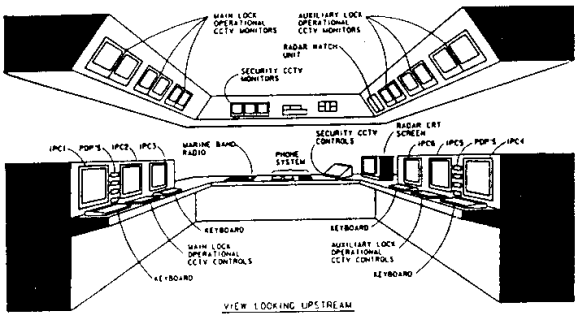

Figure C-1. Central control house operating console

(1) Operator interface. The computers will present and accept data and commands in a format conducive to human comprehension.

(2) Command device. The computers will initiate commands to the PLC's to control equipment throughout the lock and dam.

(3) Warning/diagnostics. Abnormal conditions will be annunciated to the operators, as well as diagnostic

messages of explanation. Operation and maintenance information of critical equipment will be stored for quick retrieval. Emergency instructions will be displayed.

(4) Data validity checks. The computers will check the operator commands for validity and alert the operator if an abnormal input is attempted.

(5) Data archives. Data relating to barges, lock operation, and fire alarms will be monitored and recorded (hard copy) for permanent records.

(6) Pool regulation. The logic for automatic control of the upstream pool level will be done within the computer system.

c. Computer system. The computer system hardware will consist of two completely independent subsystems, one for each lock. Each subsystem will comprise three industrial-quality personal computers (with appropriate interface cards), three color Cathode Ray Tube (CRT) monitors, three keyboards, and four programmable display pushbuttons (PDP's). The two subsystems will share a printer for hard copies.

(1) Computer program. The computer system will control two of the three possible modes of operation. Operating modes will include semiautomatic, manual, and emergency. In the semiautomatic mode, the first computer will use the PDP's to prompt the operator through a lockage sequence. The computer will handle many of the intermediate steps that do not require human intervention. In the manual mode, the operator will execute a lockage by selecting numbers from a menu, using the keyboard of computer number one. The operators individually initiate each step, such as opening a valve and then monitoring lock chamber levels. An operator may execute the same series of steps in the manual mode by means of pushbuttons located in any of the four local control houses. In the emergency mode, the computers and programmable controllers will not be involved; control will be affected by means of hard-wired overrides at the local control houses.

(2) Control menus. In the semiautomatic mode of control, the operator will initiate sequences using the PDP's. The IPC's and PLC will automatically sequence the events that do not require human intervention and prompt the operators via the PDP's. In the manual mode, the operator will initiate an action using a keyboard and color CRT monitor (or pushbuttons in the local control houses). Actions may be selected from a series of "Menus" that will appear on the color monitor; this mode of control is also referred to as the "Menu Control." The operator will initiate a device by simply selecting a number corresponding to the desired action from the monitor, typing the number on the keyboard, and then pressing the return key on the keyboard. The graphics menu will display the following "Graphic Display Window Selection."

(a) Upstream miter gate control.

(b) Filling valve control.

(c) Downstream miter gate control.

(d) Emptying valve control.

(e) Upstream hydraulic system bypass control.

(f) Downstream hydraulic system control.

(g) Traffic light control.

(h) Strobe light and warning horn control.

(i) High mast lighting control.

(j) Emergency miter gate fire protection.

(k) Spillway gate control.

(l) Return to mode menu.

(m) Valve and gate interlock bypass.

(3) Data collection requirements. Operations of the lock and dam requires constant record keeping. Record keeping currently occupies a large percentage of the operator's time. The use of IPC's for controls offers an opportunity to streamline record keeping while improving record quality and reducing the load on the operator. Record keeping may be broken into three categories; daily, shift changes, environmental conditions, and lockage information. It is proposed that daily records be entered using the IPC's dedicated for record keeping.

(a) The operator will manually enter such daily data as precipitation and the ice code and details.

(b) Shift change records occur at the beginning of each new shift. Using the IPC's, the operator will manually enter the following shift change data:

- Lock operator number.
- Number of vessels waiting above and below.
- Upper and lower pool current condition.
- Weather code and severity.
- Surface code and severity.
- Wind direction and velocity.

(c) Using one special-function keystroke, the operator will then direct the computer to automatically record the following data:

- Lock number.
- River.
- Date.
- Time and time zone.
- Air temperature.
- Water temperature.
- Upper and lower pool elevations.
- Spillway gate settings.

(d) The IPC's can also significantly improve the manner in which the IPC's will be networked with district or regional computers via modems or fiber optic networks. (An electronic mail system can also be established between the locks and the district.) The network will allow the interchange of data between locks and the generation of reports that are not lock-specific. For each lockage, the operator will access a database and automatically record the following data:

- Vessel name.
- Vessel number.
- Vessel type.
- Directions.
- Origin.
- Destination.
- Flotilla length and width.
- Maximum barge draft.
- Number of barges loaded and empty.
- Barge type.
- Commodity code and tonnage.
- Chamber number.
- Record number.
- Number of cuts.
- Type of lockage.
- Number of light commercial boats.
- Number of recreational vessels.
- Number of passengers.
- Entry type.
- Exit type.
- Stall code, and (optional) date and time.
- Tow stop since last lockage.
- Type of assistance, if any.
- Arrival (date and time).

(e) The IPC's will reduce operator workload by assisting the operator in logging the time of occurrence of some of the following lockage events:

- Start of lockage-first cut.
- Bow over sill-first cut.
- End of entry-first cut.
- Start of exit-first cut.
- End of lockage-first cut.
- Start of lockage-second cut.
- Bow over sill-second cut.

- End of entry-second cut.
- Start of exit-second cut.
- End of lockage-second cut.

(f) The IPC's will generate reports also by providing hard copies via the printer in the central control house. Information for some of the reports can be obtained from the network links to other locks in the Navigation System. The following reports will be generated:

- Morning ice report (information on navigation conditions).
- RPT01 - Lockage & Tonnage Summary.
- RPT03 - Daily Detail Lockage Report.
- RPT04 - Locate a Single Vessel.
- RPT07 - Lockage & Tonnage Summary.
- RPTIO - List Vessel Names.
- HREOl - Weather Screen.
- HRE02 - Lock-Gate-Stage Screen.
- HRE03 - Lock Daily Hydraulics Report.
- HRE07 - Degree-Day.
- HRE08 - River Current Stage.
- Vessel log.
- Shift log.
- Lockage log.

C-2. Control Console Layout

The central control console will be located in the control room of the central control house. The console will house computers and support equipment and will permit an operator to control the entire dam and locks from one point.

C-3. Automatic Pool Regulation System

The automatic pool regulation system is a control system designed to regulate upstream pool elevation. This system will control all spillway gate movement and permit accurate control of pool elevation without operator intervention. The system will sense any abnormal conditions and alert the operator if human intervention is needed. The controls will also permit an operator to manually control individual spillway gates or shut down a gate for maintenance. Lock gates, culvert valves, and spillway gates may still be controlled by hard-wired local control stations at the local operating stations if equipment failure renders this necessary. The control system was designed to operate in five modes: initialize, automatic, manual, manual with setpoint, and maintenance.